Space Weather Technical Forecast

Issued on Wednesday, 31 May 2023 at 13:25 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of R1/R2 radio blackouts throughout. Increasing chance of Active electron fluence into the period. Slight chance of isolated G1/Minor storm intervals on 01 and 02 June.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Moderate over the last 24 hours, with two M-class flares observed. The first was a M1.3 from AR3315 in the southwest quadrant at 30/1339UTC, with the second a M1.3 from AR3323 on the southeastern limb. AR3315 has recently weakened in complexity, but still contains a weak central delta spot. AR3323 is still emerging across the limb and although analysed as an alpha classification, is expected to reveal further complexity over the coming days. AR3319 is also relatively complex in the south central disc, but has not produced any significant activity. These are three of 12 analysed regions on the visible disc, with the remaining regions generally weak, inactive or decaying. An eruption from the northwest limb during 30 May has been assessed as emanating from the farside of the disc. No Earth-directed CMEs were observed on available imagery during the period.

Solar Wind / Geomagnetic Activity: Solar winds observed at L1 have been at generally ambient levels, below 400km/s with density well below average. Total interplanetary magnetic field strength has been weak, with the north-south component varying weakly. Phi angle was predominantly negative (towards the Sun). Geomagnetic activity was Quiet.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV at GOES-16) has remained at background levels throughout. High energy electron flux (greater than 2MeV at GOES-16) has been diurnally varying between background and moderate levels. The associated 24 hour fluence has been below the Active threshold (1e8 integrated pfu), with a steady trend. Electron fluence observed at 31/0000UTC was 1.61e7 integrated pfu.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is expected to be Moderate, with an increasing risk of High levels due mainly to both AR3315 and AR3319 in the southwest quadrant and a newly numbered, but increasingly active, region AR3323 on the southeast limb.

Solar Wind / Geomagnetic Activity: A CME which left the Sun on 26 May could glance the Earth during 31 May, but with low and decreasing confidence. A high speed stream, from coronal holes 08 or 09, or a combination of both, is forecast to connect with Earth either late on 01 June or more likely on 02 June, giving estimated solar winds of 500-600km/s. Geomagnetic activity is expected to be mainly Quiet to Unsettled, with a slight chance of Active to G1/Minor Storm intervals on 01 or 02 June due to the forecast high speed stream connection.

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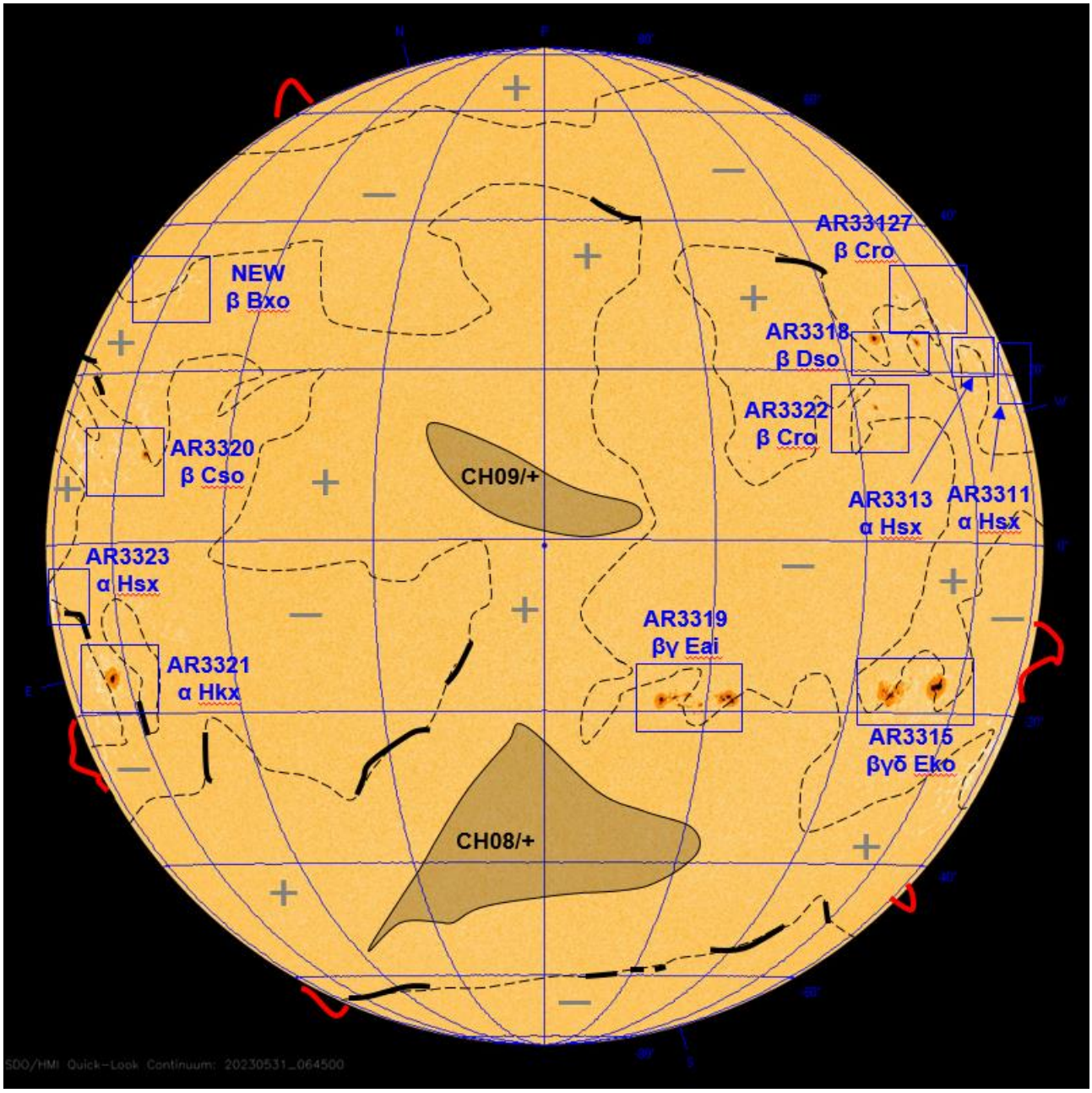
Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at background levels, however there remains a slight chance of reaching the S1/Minor Storm threshold should any larger flares occur. High energy electron flux (greater than 2MeV) is expected to remain largely below the high threshold but with an increasing chance of reaching High levels during diurnal maximums, especially later in the period. Election fluence is also forecast to rise through the period in response to increasing levels of electron flux.

Figure 1. Solar Analysis Valid 31/0800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:
A weak CME which left the Sun on 26 May, may glance the Earth either on 31 May or 01 June, but with low confidence in both potential arrival and level of impact. A large CME emanating from the northwest of the solar disc during 30 May has been assessed as erupting from the farside of the Sun.

Solar winds are currently at ambient levels. A high speed stream from coronal holes 08 or 09, or a possible combination of the two are forecast to connect with the Earth either late on 01 June or during 02 June, based on an estimated solar wind speed of 500-600km/s. Both these hole are recurrent features with similar sizes and extents to the previous rotation where speeds of around 500-600km/s were observed, lending support to this forecast. In addition, the coronal holes have not yet connected with STEREO A, which is now only observing the solar wind conditions 18 hours ahead of Earth.

Geomagnetic activity is expected to be mainly Quiet, with some Unsettled intervals. Active or G1/Minor Storm intervals are possible, but considered unlikely on 31 May due to the possible CME arrival and on either 01 or 02 June due to the possible connection with coronal holes 08 and 09.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	20	20	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Figure 2: MOSWOC Enlil showing the spread in possible arrival times for the CME which left the Sun on 26 May. There is ever decreasing confidence in a possible arrival.

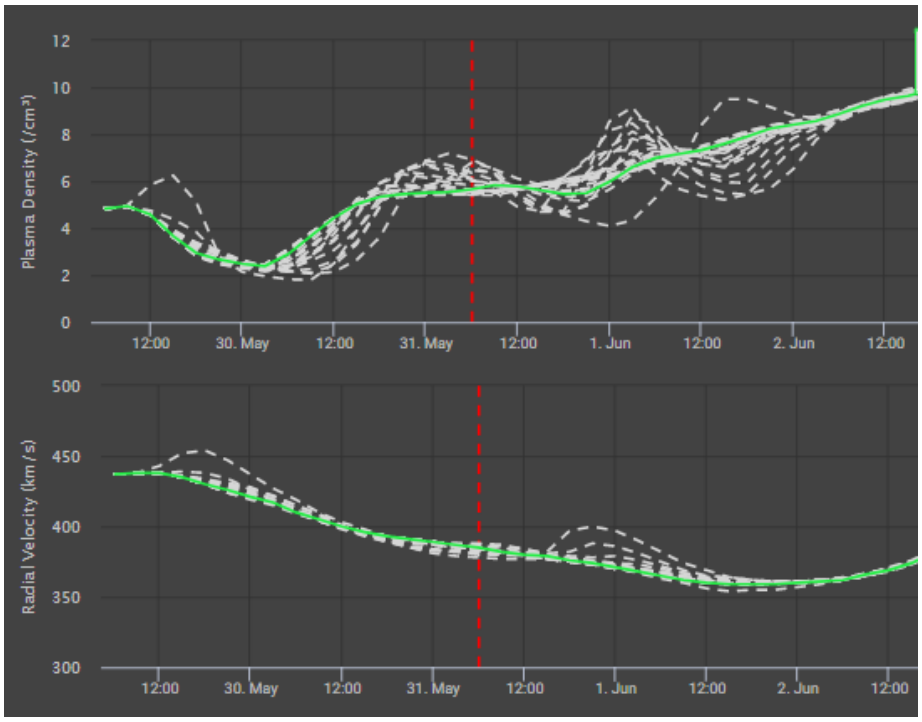
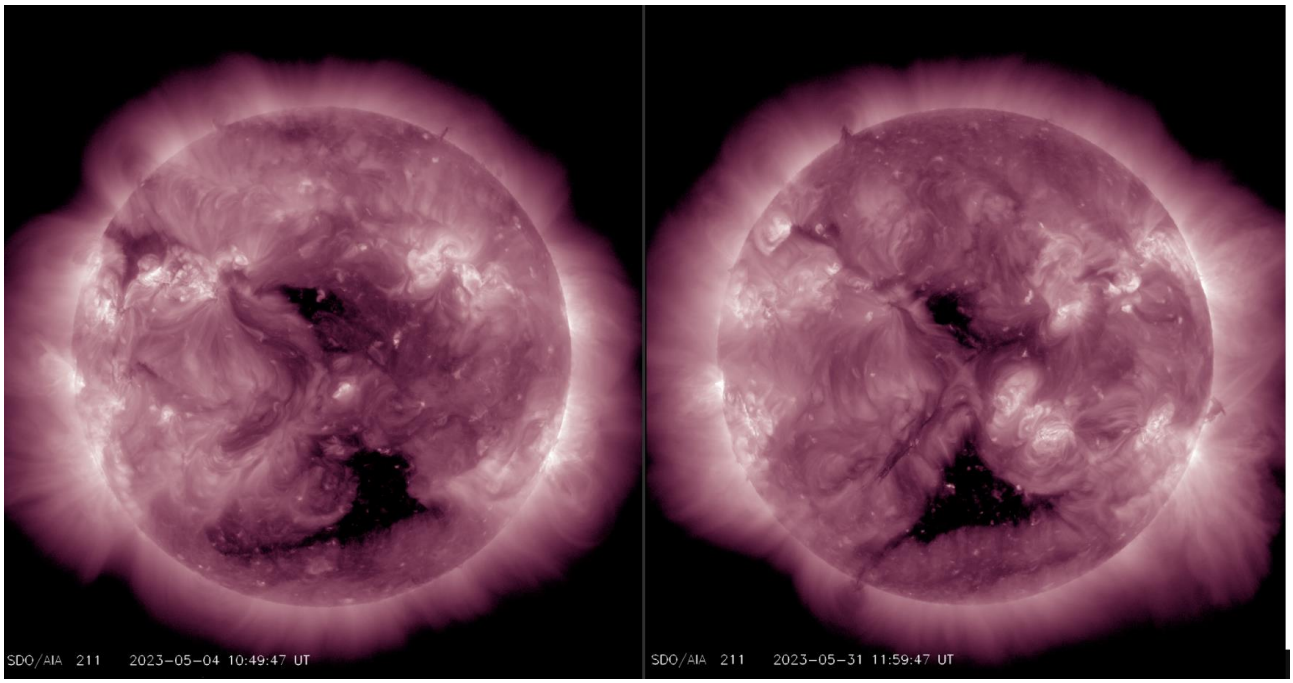


Figure 3: Comparison of coronal hole 08 (bottom) and coronal hole 09 between last rotation (left) and this rotation (right) demonstrating the consistency in shape and size between the two rotations.



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Radio Blackouts - X-Ray Flares:
Although there are 12 sunspot regions on the visible disc, only three are considered to carry a significant flare risk. AR3315 in the southwest quadrant has declined slightly, but still contains a weak central delta spot. This was responsible for an M-class flare during 30 May, but has not produced significant activity since that day. AR3319 is also showing some limited activity, but is a relatively complex region and continues to be monitored. Newly numbered region, AR3323 is producing a high level of flux, as observed on SDO imagery and is expected to reveal greater complexity as it rotates more fully onto the visible disc, having produced a recent M-class flare.

Solar activity is expected to be mainly Moderate, with a risk of High activity, due mainly to the three regions mentioned above, and a number of active regions forecast to rotate across the eastern limb from the farside through the next four days.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	40	40	40	40
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 4: GOES 16 X-ray flux

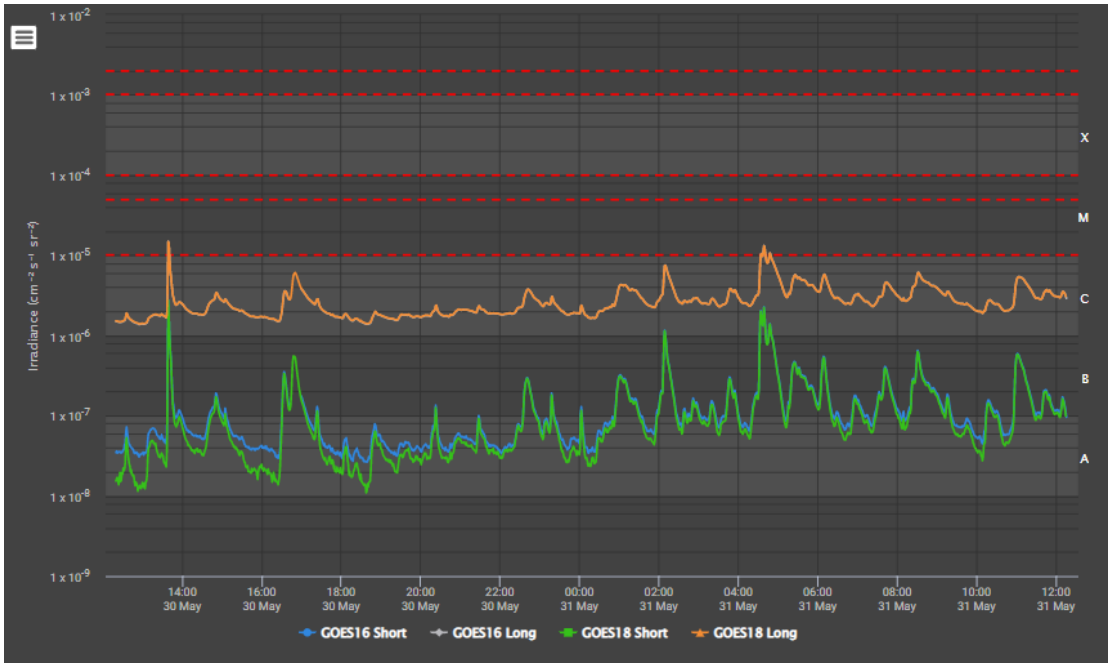

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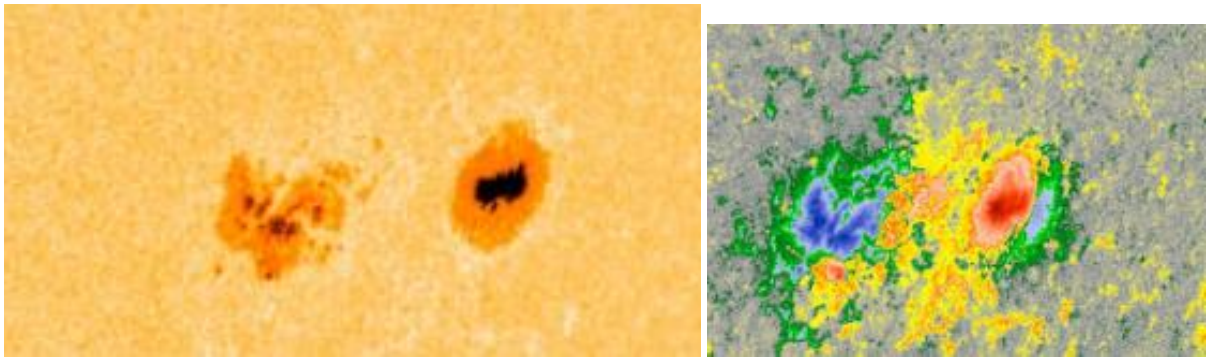
Figure 5: AR3315 (Eko/βγδ) in the southwest quadrant. A very weak delta spot is still visible as the region appears to slowly decline in complexity.



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES16, is at background levels and expected to remain so. A slight chance of S1/Minor Radiation Storms is maintained should any larger flares occur. AR3315 remains the most likely source region in the near term as it continues to transit the southwestern hemisphere.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) has varied between moderate and background levels, as the bulk of the recent electron accumulations in the radiation belts are modelled to be at a sub-GEO orbit. Initially on 31 May background to moderate levels are expected in the absence of any significant modifying factors. The onset the next high speed streams, from either coronal hole 08 or 09 from late on 01 June or during 02 June may lead to an increasing risk of exceeding the high (1e3pfu) threshold on diurnal peaks.

Associated 24 hour fluence values are likely to show an increasing trend through the period, especially following the onset of the forecast high speed streams. Active (1e8 integrated pfu) thresholds are then likely to be exceeded by the end of the period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	30	40	50
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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